No. 745,853. PATENTED DEC. 1, 1903.

# H. C. INGRAHAM.

## PROPELLER.

APPLICATION FILED APR. 3, 1903.

MODEL.

Fig. 1.

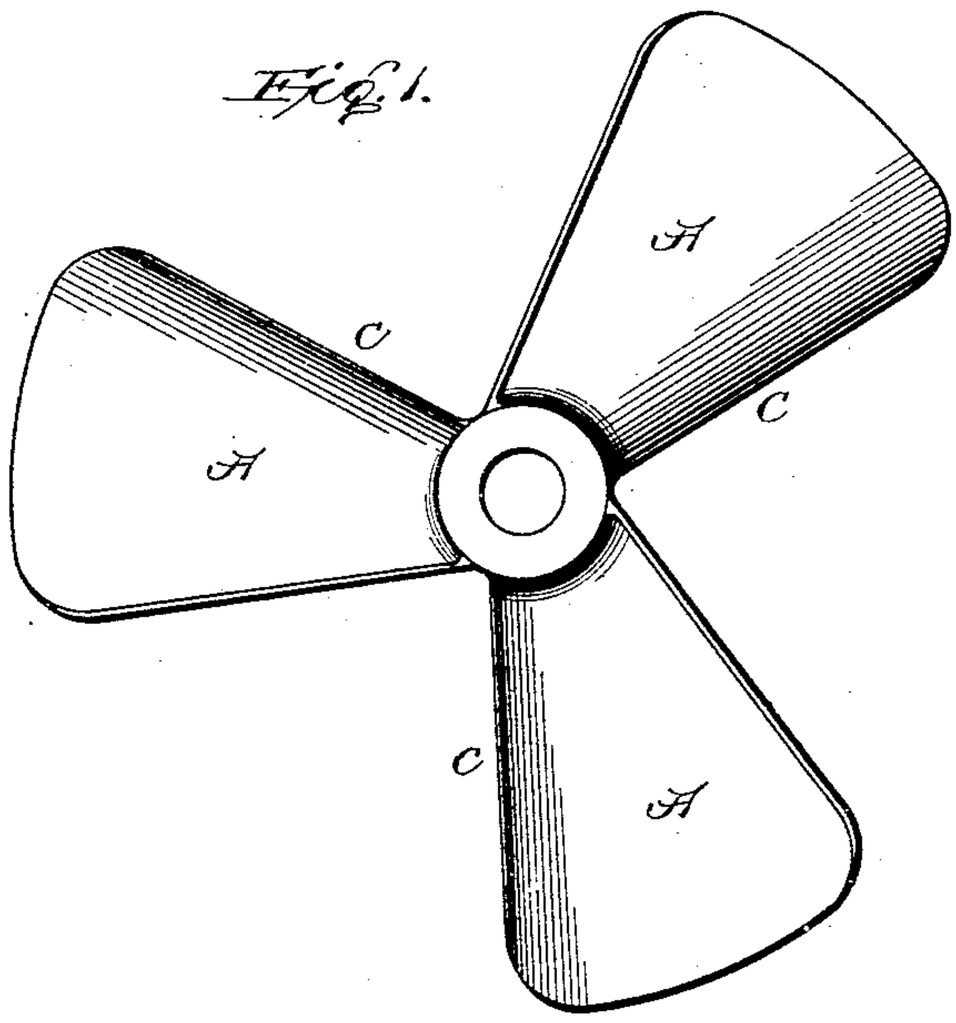



Fig. 2.

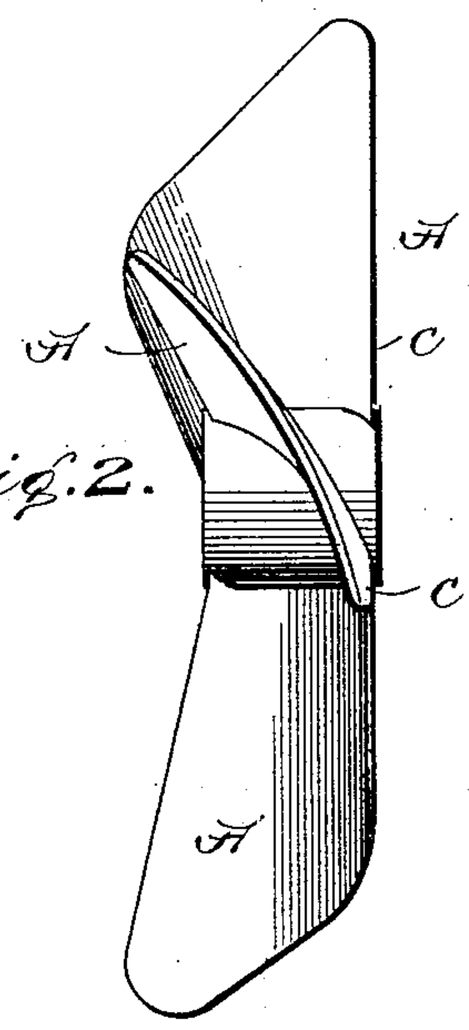
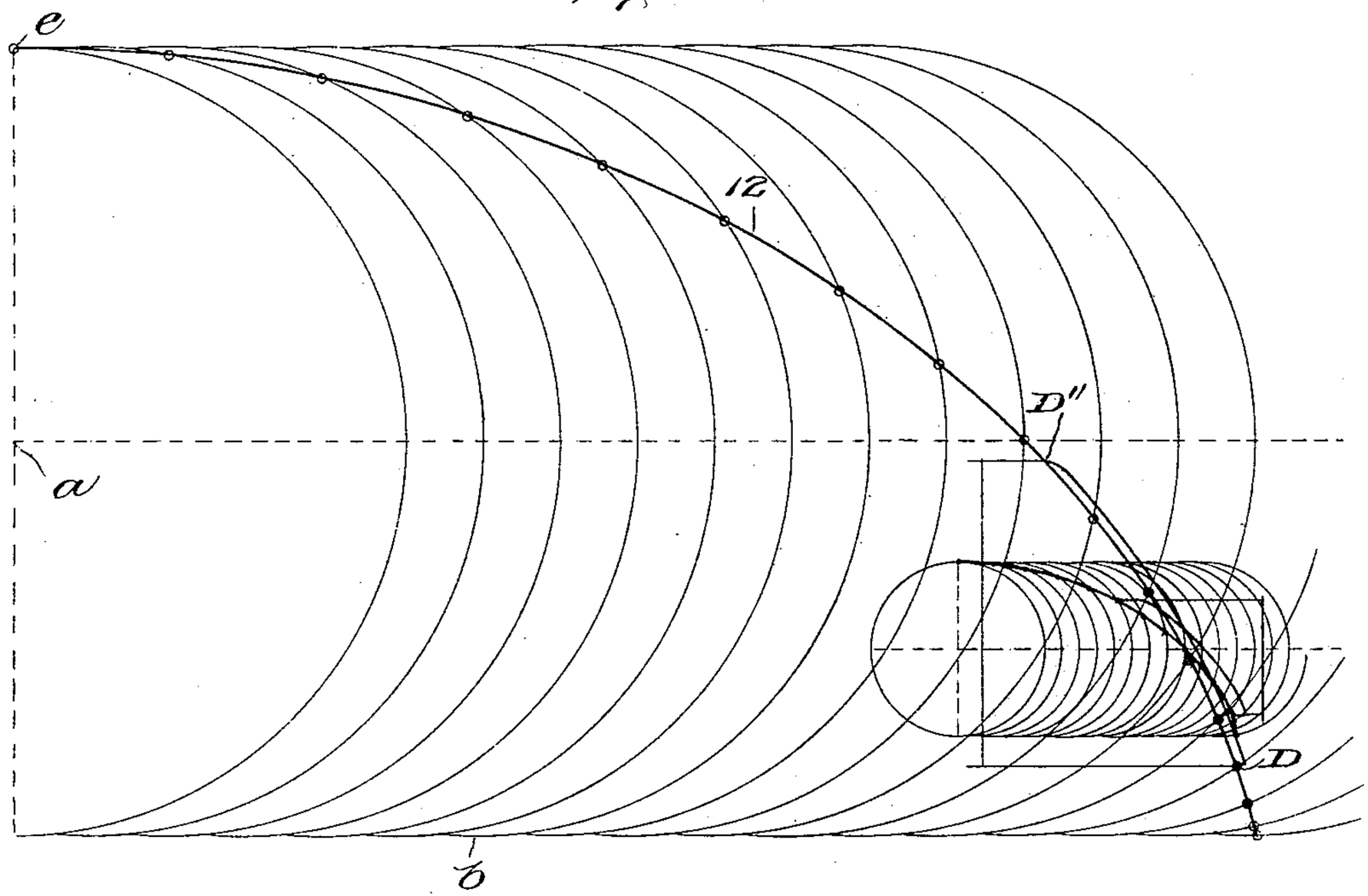



Fig. 3.




Witnesses
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No. 745,853. Patented December 1, 1903.

# UNITED STATES PATENT OFFICE.

HENRY C. INGRAHAM, OF NEW HAVEN, CONNECTICUT.

## PROPELLER.

SPECIFICATION forming part of Letters Patent No. 745,853, dated December 1, 1903.

Application filed April 3, 1903. Serial No. 150,905. (Model.)

*To all whom it may concern:*

Be it known that I, HENRY C. INGRAHAM, a citizen of the United States, residing at New Haven, in the county of New Haven and State of Connecticut, have invented new and useful Improvements in Propellers, of which the following is a specification.

The primary object of my invention is to produce a propeller adapted by the peculiar curvature which is imparted to the face of its blades to impart to the water in which it turns a longitudinal motion or a motion in a direction coincident or parallel with a propeller shaft or axis about which the blades turn. The blades are given a concavo-convex form, and to make their working faces most effective I avail myself of the use of a true cycloidal curve or a line wherein the angles of lead of pitch increase on a true cycloidal curve as drawn with a circle the full size or diameter of the propeller at its outer end or, if preferred, of any smaller diameter of such a circle, the inner end of the blade proximate to the hub being drawn in like manner and with a circle of the diameter of the hub or less.

The invention consists, essentially, of a propeller the blades whereof are constructed or formed with a working face made concave on a line which represents a true or substantially true cycloidal curve and utilizing said curve either for a wide or narrow blade by employing more or less of said curved line.

In the accompanying drawings, forming part of this specification, Figure 1 represents an elevation of the working face of a propeller constructed according to my invention. Fig. 2 is a plan view of the propeller, showing the blades and the hub. Fig. 3 is a diagram showing the method of obtaining a curve for the working face of the blades.

The essential object of the invention being to impart a more positive movement to the vessel in a forward direction and at the same time obviate the presence of any surfaces or parts which serve as a drag to impede said forward movement, I construct the blades A with preferably true geometrical precision on a cycloidal curve for an increased lead and whereby each progressing point of energy in this increase is always at or about right angles to the propeller shaft or axis of rotation of the blade or movement of vessel in a forward direction. This formation of the working face of the blade results in the water being pushed in a horizontal direction coincident or parallel with the axis of the propeller, neither pushing the water from the hub or shaft nor toward the center during the revolution of the propeller. The entering or leading edge *c* of the blades I prefer to form at an angle of not less than eighteen degrees pitch for its entire length, which, in conjunction with the cycloidal curvature given the working face of the blade, insures a uniform increase of lead for the entire length of blade, thereby exerting a uniform pressure at all points in a direction directly to the rear and substantially coincident with the shaft or axis of the propeller and effecting displacement of the water in that direction. In actual operation the increase of lead serves to compress the water progressively at each point of revolution until the rear edge of the blade is reached, and as the successive portions of the blade displace the water the water in turn flows back to fill the void made by the blade cutting the water and pushing the body of water rearward, and thus strongly reacts against the succeeding blade in its revolution. The energy thus produced by the return of the displaced water is found to be considerable, and it assists to no small degree in the performance of the object I have in view for this propeller—namely, to impart to the water in which the propeller turns a longitudinal motion in a direction coincident or parallel with the axis of the propeller, thereby driving the vessel forward in an effective manner and dispensing with surfaces or projections which tend to form a "drag" or impediment to the progress of the vessel, which is important, as such "drags" cause a loss of power and efficient energy which might otherwise be utilized to promote the progress of the vessel in a forward direction. Because of the form given the working faces of my blades the energy developed from all points thereon is utilized to drive the vessel forward, and there is a total absence of "dragging" surfaces or points, as the curve line adopted for the working face of the blade is geometrically correct and most effective in operation and practical results.

In Fig. 3 I illustrate diagrammatically the

method pursued to obtain the working face of my blades. In this figure, *a* may represent the center of the generating-circle, which circle represents the diameter of the wheel desired, and the line *b* represents the director, and the point *e* in the circle is the generator. By placing a scriber upon the generator or point *e* in the circumference of the circle and rolling the circle on the director or line *b* the curved line 12 will be described, which represents the true cycloidal curve.

Referring again to the generating-circle in Fig. 3, the line D represents the point on the curved line 12 where the blade would commence and the line D″ represents the point of the blade at its outer edge, and said blade in the case of a wide blade, as in Fig. 1, is accordingly increased in width to the right of a true central radial line, which disposition will occur when the curved line rises above the hub.

Fig. 4 is similar to Fig. 3 and shows the method of obtaining the curve near the hub outside of the usual fillet-line. In all respects it is similar to the description for Fig. 3.

The foregoing advantages are due to the adoption for the working face of the blades of the true line of a cycloidal curve for an increased lead to the working face of the blade, which gives a gradual compression of water to the rear and always in a line coincident or parallel with the propeller-shaft and always in exact proportion at every point on the blade between the hub and outer end of said blade, while the back movement of the water to fill the void caused by the increased lead or compression of water after the blade has passed a given point adds much to the aggregate efficiency of the propeller.

In the preferred construction I make the outer ends of the blades as thin as consistent with that strength which is required for the blades, and as each blade at the hub end is nearly at the angle of forty-five degrees across hub this gives the greatest strength against breakage from the rearward thrust or revolving strain. Therefore the blades need not be made cumbersome to resist breakage and leaves the working face of each blade efficient at every point of its length.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A propeller-blade a cross-section of which at any and all points between the hub and outer end represents a segment of a cycloidal curve and the curved portions being formed from generating-circles whose diameters increase from the hub outwardly.

2. A propeller-blade having a curved working face the curvature of which at its outer end represents a segment of a cycloidal curve formed from a generating-circle whose diameter is substantially the diameter of the propeller and which curvature, at the inner end of the blade, is formed from a generating-circle of less diameter than the diameter of the propeller.

3. A propeller-blade having a curved working face the curvature of which, at the inner and outer ends and intermediate points each represents a segment of a cycloidal curve formed from generating-circles whose diameters decrease toward said inner end.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

HENRY C. INGRAHAM.

Witnesses:
EDWIN S. PICKETT,
JAMES BISHOP.